of the combination of "the pleasure of intense stimulus" and the "pleasure of conflict" in our enjoyment of a tragedy, are models of delicate æsthetic analysis. The author's attitude towards the various current theories of "play" is eminently judicious. As he well points out, both the "surplus activity" theory and the "recreation" theory are one-sided, the former doing less than justice to the pastimes of adults, the latter to those of children. His own view that play must be regarded by the biologist primarily as the great educator and perfecter of imperfect instincts has been most nearly approached by Prof. Baldwin. Prof. Groos's treatment of the sociological aspects of "play," both as the child's earliest form of experimentation and as the earliest school of obedience to authority, should prove useful to students of ethics as well as to professed sociologists. The admirable literary style of the book, no less than the interest of its contents, should recommend it to all persons of general culture who care for anthropological studies. A. E. T.

Physique et Chimie Viticoles. By A. de Saporta. Pp. iv + 300. (Paris: G. Carré and C. Naud, 1899.)

IN the preface to this book, contributed by M. P. P. Dehérain, the immense importance of the vine culture to France is pointed out, the wine from the department of Hérault alone having in 1897 a value of 212,000,000 francs. The questions of suitability of soil, of manures, of the remedies against the many diseases of the vine, of fermentation, and preservation of wine all depend largely upon simple chemical and physical considerations; hence arises the necessity for such a work as the present, dealing with the physics and chemistry of vine culture and wine production. Of the eight chapters composing the book, the first two are preliminary, giving a very brief outline of the atomic theory and the measuring instruments used in the laboratory. The third chapter deals with the soil, especial attention being directed to the use of various insecticides, and to the causes of vine disease generally residing in the soil. In the third chapter, on account of the importance of the estimation of calcium carbonate in the soil, numerous calcimeters are described, some of considerable and apparently unnecessary complexity, as, for example, the self-registering calcimeter of Houdaille. The description of the properties of manures is lucid, and their analysis is treated in a simple manner. Chapter vi., dealing with the remedies for vine diseases, is, on account of the evident practical knowledge of the author, the most valuable portion of the book. The number of remedies that have been invoked to combat mildew, black rot, chlorosis, phylloxera, and other vine diseases, is so great as to render their classification and intelligent use difficult. Especial attention is here directed to the use of carbon bisulphide, ferrous sulphate, sulphur, copper sulphate and acetate, and mercury salts, the last-named being emphatically condemned in spite of their undoubted efficacy in combating fungoid diseases. The concluding chapters deal briefly with the fermentation of the grape, analysis of the wine, and the diseases to which it is liable. The book will be of great practical service to vine growers.

Cours Élémentaire de Zoologie. Par Remy Perrier. Pp. 734. 697 illustrations. (Paris: Masson et Cie., 1899.)

THIS work contains a great deal in brief that is to be found in its predecessor, the author's "Éléments d'Anatomie Comparée," published in 1893. In some respects it may be said to be a "Grundriss" to that volume, but, in contradistinction to it, the Vertebrata are here treated on a greater equality with the Invertebrata, and the order of presentation is more rational and in accordance with precedent. For example, the Chætopod Worms are dealt with before the Arthropods, the inversion of this order being a notorious feature of the "Éléments." Chapter i. is devoted to broad principles and definitions, Chapter ii. to the elements of histology, and Chapter iii. to the classification of the metazoa—177 pp. in all. Tables of affinity and structural relationship are here and there given, and the 565 remaining pages of the work are devoted to a systematic consideration of each of the greater groups of animal forms in an ascending order, the Echinoderms, Rotifers, Polyzoa, and Brachiopods being taken after the Cœlenterates and before the Leeches and Worms. Some of the groups receive but scanty treatment, meagre and wholly insufficient, and throughout the work the author has conspicuously neglected the rendering clear the extremes of modification of the great groups, which we consider should be an indispensable feature of an elementary text-book on organic forms that shall do justice to our present knowledge. In dealing with such an assemblage as the Tunicata, where octoradiate, valved, stalked, and many other well-known forms occur, a great opportunity has in this way been lost, and the same may be said of the author's treatment of the Bryozoa.

The illustrations are for the most part good and clear; some of the new ones are admirable, and we congratulate the author upon such as his aortic arch series (p. 602), which are the most accurate and up to date of any text-book set yet published. They are sure to be popular and reproduced *ad nauseam*. But why that old nightmare the Cuvier's "Chimæra" (Fig. 589), a badly drawn Chimæra with a Callorhynchus tail! Surely the time has come when this and other persistent atrocities of our text-books, which have so long offended, should be condemned.

A really sound elementary treatise on zoology has long been a desideratum, and the present work is the outcome of a commendable attempt to supply the need. Though desperately thin in parts it is up to date in its leading themes, well arranged, and written in a good easy style, and it may be safely recommended as trustworthy so far as it goes.

LETTERS TO THE EDITOR.

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Thermometric Scales for Meteorological Use.

IN the course of some recent work on the meteorology of Ben Nevis, which involved extensive extracting and computing work, I have again had forcibly impressed on me the great advantage which Fahrenheit's thermometer has over that of Celsius for meteorological use, especially in temperate regions.

In chemistry and physics the range of temperature covered is so great that Celsius' scale, which is now universally used, adequately meets every case. The size of the degree and the change of sign at the melting point of ice do not cause any inconvenience in the laboratory. It is otherwise in the meteorological observatory. There the range of temperature dealt with is very restricted, and the Celsius degree is too large, while the change of sign in the middle of the working part of the scale is simply intolerable. The latter peculiarity is the fruitful introducer of error into both the observations and the reductions, and besides it greatly increases the fatigue of both classes of work.

In view of the agitation to abolish the use of Fahrenheit's scale, and to replace it universally by that of Celsius, it may not be inopportune to direct attention to some of the advantages in securing accuracy and in relieving labour which Fahrenheit's scale offers over that of Celsius when used for meteorological purposes.

In tropical countries it matters little whether one scale or the other is used, except that the size of Fahrenheit's degree is much

the more convenient, as the first decimal place is always sufficient. But in Europe and in North America, where the greater number of meteorological observatories is situated, the temperature falls every year below the freezing point of water. In some localities it passes quickly through this point and remains constantly below, often far below it, returning again in the spring and passing as quickly through it again in the beginning of summer, to remain constantly above it until it drops away again in the fall of the year In such places, where, however, the population affected is limited, the use of Celsius' scale is not open to very much objection. With the exception of a few days in the fall, and again in the spring of the year, the temperatures are either continuously positive or continuously negative; and during one-half of the year the observer reads his thermometer upwards, while during the other half of the year he reads it downwards. When he has got well into the one or the other half of the year, he will make no more errors than those that he is personally liable to under circumstances of no difficulty. But at and near the two dates when the temperature is falling or rising through that of melting ice the case is very different. If the rise or fall is rapid, his task is comparatively easy, and, after a few unavoidable mistakes, he has succeeded in inverting his habit of reading. But, in those parts of Europe and North America which carry nearly the whole of the population, the temperature in winter is frequently oscillating from one side to the other of the melting point of ice. If the observer is compelled to use a thermometer which he must read upwards when the temperature is on one side of that point, and downwards when it is on the other side, and if he may be called on to perform this fatiguing functional inversion several times in one day, it is certain that he will suffer from exhaustion, and that the observations will be affected with error.

Were there no other thermometric scale available but that of Celsius, we should simply have to put up with it, and endure the inconvenience of it; but, when we have another scale, one devised primarily for meteorological observations in the North of Europe, by a philosopher who constructed it with a single eye to its fitness for what it was to be called upon to measure, and when, in addition, this scale is still exclusively used in a large proportion of the meteorological observatories of the world, it seems almost incredible that amongst reasonable people, be they scientific or non-scientific, there should be a powerful agitation to abolish the scale which was devised for its work, which excludes error in so far as it can be excluded, and to replace it by one which, besides other defects, introduces, in the nature of things and of men, *avoidable* errors, the elimination of which is the first preliminary of the scientific treatment of all observations in nature.

Every meteorologist in northern countries who makes use of the data which he collects knows that when his temperatures are expressed in Fahrenheit's degrees, he can discuss them at much less expense both of labour and of money for computing than when they are expressed in Celsius' degrees; yet such is the apprehension of even scientific men when brought face to face with the risk of being ruled "out of fashion," that meteorologists who use Fahrenheit's scale, though they fortunately do not give up its use, seem to be disabled from defending it.

What is this stupefying fashion, and can it not be made our friend?

Fahrenheit lived and died before the decimal cult or the worship of the number ten and its multiples came into vogue; but, whether in obedience to the prophetic instinct of great minds or not, it almost seems as if he had foreseen and was concerned to provide for the weaknesses of those that were to come after him. The reformers of weights and measures during the French revolution rejected every practical consideration, and chose the new fundamental unit, the metre, of the length that it is, because they believed it to be an exact decimal fraction one ten-millionth of the length of the meridian from the pole to the equator. Is it an accident that mercury, which was first used by Fahrenheit for filling thermometers, expands by almost exactly one ten-thousandth of its volume for one Fahrenheit's degree?

Again, how did Fahrenheit devise and develop his thermometric scale? A native of Danzig and living the first half of his life there, he considered that the greatest winter cold which he had experienced in that rigorous climate might, for all the purposes of human life, be accepted as the greatest cold which required to be taken into account. He found that this temperature could be reproduced by a certain mixture of snow and salt. As a higher limit of temperature which on similar grounds he held to be the highest that was humanly important, he took the temperature of the healthy human body, and he subdivided the interval into twenty-four degrees, of which eight, or one-third of the scale, were to be below the melting point of pure ice, and two-thirds or sixteen were to be above it. Fahrenheit very early adopted the melting temperature of pure ice for fixing a definite point on his thermometer, but he recognised no right in that temperature to be called by one numeral more than by another. The length of his degree was one-sixteenth of the thermometric distance between the temperature of melting ice and that of the human body, and the zero of his scale was eight of these degrees below the temperature of melting ice, and not, as is often thought, the temperature of a mixture of ice and common salt or sal-ammoniac. Fahrenheit, as has been said, was the first to use mercury for filling thermometers; and being a very skilful worker, he was able to make thermometers of considerable sensitiveness, on which his degrees occupied too great a length to be conveniently or accurately subdivided by the eye. To remedy this he divided the length of his degree by four, and the temperature from the greatest cold to the greatest heat which were of importance to human life came to be subdivided into 96 degrees.

Had he lived in the following century he would have been able to point out that on his scale the range of temperature within which human beings find continued existence possible is represented by the interval 0 to 100 degrees, and there can be little doubt that this would have secured its general adoption. Its preferential title to the name Centigrade is indisputable. Perhaps this may be an assistance to its rehabilitation as the thermometer of meteorology.

J. Y. BUCHANAN.

Cambridge, August 4.

On the Deduction of Increase-Rates from Physical and other Tables.

THE problem treated by Prof. Everett in your issue of July 20, p. 271, allows a somewhat simpler solution. Take the example given by Prof. Everett. To find the value of $\frac{dp}{d\theta}$ at the temperature 105°, we have only to consider the columns for Δp, $\Delta^3 p$, $\Delta^5 p$, &c. In each of these columns there are two numbers, one just above and one just below the horizontal line, corresponding to the value $\theta = 105°$. In the column for Δp, for instance, these two numbers are 408 and 470, in the column for $\Delta^3 p$ they are 5 and 8 If now m_1, m_3, m_5, &c., are the means of each of these two numbers, so that in this case $m_1 = 439$, $m_3 = 6.5$, we have:

$$\frac{hdp}{d\theta} = m_1 - \frac{m_3}{2.3} + \frac{m_5}{2.3.4.5} 2^2 - \frac{m_7}{2.3.4.5.6.7} 2^2 3^2 + \ldots$$

If p be capable of being expressed in the form $A + B\theta + C\theta^2$ only the first term m_1 is required; if

$$p = A + B\theta + C\theta^2 + D\theta^3 + E\theta^4$$

only the first two terms $m_1 - \frac{m_3}{2.3}$ are required, and so forth. In these cases the solution is exact, whereas in general the method gives only approximations closer and closer the more terms are added.

The difference between my solution of the problem and Prof. Everett's is only formal. It may readily be seen that in Prof. Everett's notation

$$2m_1 = d_1 + u_1,\ 2m_3 = d_2 - u_2,\ 2m_5 = (d_3 + u_3) - (d_2 - u_2),$$

which makes his equations special cases of my expression for $\frac{hdp}{d\theta}$. The proof of my expression may be given by the calculus of finite differences. For simplicity let us write $x = \theta - 105°$, and let us develop the function p in the form:

$$p = a_0 + a_1 x + \frac{a_2}{2} x(x-h) + \frac{a_3}{2.3}(x+h)x(x-h) + \ldots$$

General terms:

$$\frac{a_{2n}}{2.3.4 \ldots 2n}(x + (n-1)h) \ldots x \ldots (x - nh).$$

$$+ \frac{a_{2n} + 1}{2.3.4 \ldots 2n+1}(x + nh) \ldots x \ldots (x - nh)$$